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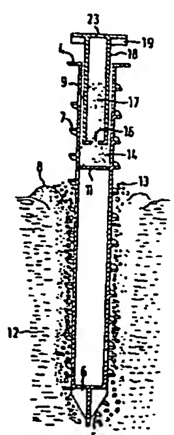
(54) **Erection of a structure on piles.**

(57) A structure, *e.g.* a temporary bridge, is erected on piles of adjusted height. The piles 9 used are hollow and have on their exteriors spiral propelling elements, *e.g.* a spiral blade 7, which, when the pile is driven rotatively under axial load, draws the pile into the ground. On reverse rotation still under axial load compaction occurs of the surrounding ground 12 and any added sand, stone or the like 13 to assist in consolidating the ground, particularly if the ground is soft. The height of each pile is adjusted by a hollow adjuster 18 which is inserted into the open top of the pile and contains sand 17 which is discharged into a chamber 14 in the pile top to form a bed on which the adjuster 18 rests to determine the extent by which it projects from the pile and thus the effective pile height.

FIG. 2



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ERECTION OF A STRUCTURE ON PILES

The present invention relates to the erection of a structure, e.g. a temporary bridge or a landing pier, on piles and also to a pile arrangement for use in such erection.

Hitherto, when erecting a temporary bridge, landing pier, or the like, it has been the usual practice to drive steel H-beams into the ground using for example a pile driving machine, the beams acting as piles, bridge piers, or the like. Such driving work causes vibration and noise and other serious environmental problems. Also when the ground is soft and its bearing power for the H-beams is low, difficulties may arise because of settlement of the beams in use. Again, in practice, since the materials including the H-beams have to be cut, welded, etc. on site, many problems in terms of the working performance, working safety, etc. arise.

It is a primary object of the present invention to provide a method for the erection of structures, e.g. temporary bridges, which militate against the above defects.

It is another object of the present invention to provide a method for the erection of structures on piles giving a greatly improved working efficiency.

It is a further object of the present invention to provide a method for erecting temporary bridges and other structures which gives the piles or piers large bearing power not only horizontally but also vertically even in soft ground.

According to the present invention, a method of erecting a structure on piles, e.g. a temporary bridge,

comprises the steps of driving a cylindrical pile into the ground under a self-propelling action caused by rotation of the pile by external force, stopping driving of the pile when it reaches a predetermined depth, introducing into the pile from above a height adjuster which extends partially into the pile, adjusting the extent of projection of the height adjuster into the pile, repeating the above procedure to drive and adjust the height of a number of the piles, and erecting a structure on the driven piles.

If necessary the method may include the step of tightly compacting the soil around the pile by reversing rotation whilst preventing extraction displacement of the pile and if desired sand, crushed stone, or another consolidating material can be applied around the pile from above to improve compacting of the ground.

The compacting step may of course be omitted if the ground condition is good, e.g. it is not too soft, and when the ground is soft driving in of a pile may be effected in stages with compacting operations therebetween.

Rotative driving of the piles may be carried out by a prime mover, such as is used for driving an earth-auger, the prime mover being suspended from the boom of a wheeled crane, crawler crane, truck crane, or the like (hereinafter referred to as "a mobile crane") and being mounted on the top of a pile being driven in. Other components of the structure such as bridge girders and cover boards may also be positioned on the piles by the mobile crane.

The invention also provides a pile arrangement for use in the above method comprising a hollow pile which is

closed at one end and open at the other, the pile having a spiral propelling element on its exterior and extending along a substantial portion of its length and further having an internal partition spaced from its open end to provide a chamber receiving sand or the like, and a hollow height adjuster which is constructed to project into the chamber and to contain sand or the like to be controllably discharged through its bottom to vary the depth of sand within the chamber and thus the extent to which the adjustor projects from the chamber.

The above and other objects of the present invention will be more fully understood by reference to the following detailed description illustrating embodiments in accordance with the present invention, when taken in conjunction with the accompanying drawings, wherein:

Fig. 1 is a side elevational view of one embodiment of a pile with a prime mover for driving an earth-auger secured to the upper end of the pile;

Fig. 2 is a longitudinal sectional view of the pile of Fig. 1 driven into the ground with a height adjuster entered in the upper portion of the pile;

Figs. 3 to 5 are schematic views showing by way of example the erection of a temporary bridge using piles of Figs. 1 and 2 and a mobile crane, and applying a method according to the present invention;

Fig. 6 is a section on the line VI-VI of Fig. 7 of one embodiment of a height adjuster for use with a pile of Figs. 1 and 2;

Fig. 7 is a plan view of Fig. 6;

Fig. 8 is a cross-section of the height adjuster of Figs. 6 and 7 taken on the line VIII-VIII of Fig. 6;

Fig. 9 is a section on the line IX-IX of Fig. 10 of another embodiment of a height adjuster; and

Fig. 10 is a plan view of Fig. 9.

Referring now to Figs. 1 and 2, the illustrated pile 9 comprises a pipe-like body of metal, preferably steel, having a definite length and having an open upper end and a closed lower end. A flange 4 is fixedly secured to the upper end of the hollow pile 9 so that a prime mover 1 can be mounted on it by means of a connector 3 having any desired design suitable for establishing operational connection therebetween for driving the pile rotationally. The body of pile 9 is further provided externally and over substantially its entire length with a propelling element 7 which is in the embodiment shown a spiral blade. Further, at the closed end of the pile 9 there are tip blades 5, 6 having a generally conical configuration with the apex directed downwards. Fixedly secured to the inner wall of hollow pile 9 is a partition 11 at a suitable position below the upper end so as to form a height adjusting chamber 14 to receive a height adjuster 18 which adjusts the height of a bridge pier.

Fig. 2 shows a pile 9 when being driven into the ground and with the height adjuster 18 in position in the height adjusting chamber 14.

The height adjuster 18 in Fig. 2 has the form of a cylinder with an outer diameter somewhat smaller than the inner diameter of hollow pile 9 and a height somewhat greater than the depth of the chamber 14. The upper end of height adjuster 18 is covered by a rectangular plate 19 having centrally a sand supply orifice 23. The lower

end is closed by a bottom plate having centrally a sand discharge orifice 16.

The discharge orifice 16 may be provided with a valve 15 as described below with reference to Figs. 6 to 8.

Further, in Fig. 2, there is shown sediment or soil 8 displaced on rotation of pile 9 due to the excavating action of spiral propelling blade 7 and consolidation material 13 used for tightly compacting ground 12 around the pile.

Figs. 3 to 5 show a method using piles 9 of the present invention and height adjusters 18 of erecting a structure, e.g. a temporary bridge, using a mobile crane 2.

Firstly, as shown in Fig.3, a pile 9 as shown in Fig. 1 is secured by connector 3 to a prime mover 1, such as is used for driving an earth-auger, suspended from the forward end of the boom of mobile crane 2, and the pile is then driven rotatively by prime mover 1 so that the blade 7 draws the pile into the ground 12 and so that soil or sediment 8 is displaced upwards by means of tip blades 5, 6. When the pile reaches a predetermined depth, the prime mover 1 is stopped, and is then driven in reverse with pile 9 still loaded downwards under the load of the crane boom 10. As a result the blade 7 operates to force sediment or soil 8 and any consolidation material 13, that is sand, crushed stone or other suitable material, supplied from above, downwards and outwards around pile 9 so as to be compacted tightly. This continues until the pile 9 begins to move upwards and when this occurs, the rotation of prime mover 1 is

stopped, connector 3 is separated from flange 4,and driving-in of the pile 9 is complete.

When the ground is soft, in order to ensure ultimate good compaction of the ground around the pile, driving may be effected by repeated driving-in, compaction and pile withdrawal steps. Thereby compaction is effected in stages and can be assisted by feeding in of consolidation material in the compaction stages.

After a number of piles 9 have been driven into ground 12 within the range of boom 10, the height adjusters 18 are introduced into their chambers 14 using the boom 10. Each height adjuster 18 is filled with sand 17 and raised bit by bit by the boom 10 so that the sand 17 is discharged gradually through valve 15 or orifice 16. This continues until the height of the pile plus the height of plate 19 above the pile, when the adjuster rests on the discharged sand, equals the required height of that bridge pier. When the heights of all the plates 19 have been so adjusted to align them, steel girders 20 of a standard profile are laid on the plates 19 by a crane hook on the boom 10 as shown in Fig.4 and fixedly secured to base plates 19 by suitable fastening mountings 21 as indicated diagrammatically in Fig. 5.

Standard cover boards 22 are now laid on the girders 20 still using the mobile crane 2. The crane 2 may now be moved onto the section thus built and the operation repeated as shown in Fig. 5 until a temporary bridge having a predetermined length and width is eventually erected.

To remove a thus-erected temporary bridge, the

operations are reversed, i.e. after cover boards 22 and bridge girders 20 are lifted, the height adjusters 18 are withdrawn from the piles, which are then extracted using the prime mover 1 and driving it in the reverse direction which operation is assisted by the propelling action of spiral blade 7.

Referring now to Figs. 6 to 8, the height adjuster 18 shown is of metal, preferably steel, has at its bottom a centrally-disposed sand discharge orifice 16 controlled by a valve 15 which when abutting the underside of the bottom closes the discharge orifice 16. A cross-shaped stop 30 is provided on the valve 15 and engages abutments 31 to hold the valve closed, but when the valve 15 is angularly displaced by any suitable means from the position in which the arms of the stop 30 abut abutments 31, the valve 15 drops under its own weight to open the discharge orifice 16.

In use, the height adjuster as just described is inserted into chamber 14 leaving the valve 15 slightly spaced from the partition 11. The adjuster is then filled with sand which is allowed to flow through orifice 16 into chamber 14. By raising the adjuster bit by bit, the depth of sand in the chamber can be controlled, and, when raising of the adjuster is stopped, the valve 15 rests on the sand and on release of the adjuster the valve closes off the orifice 16 so determining the height of the pile/adjuster combination.

The second embodiment of height adjuster shown in Figs. 9 and 10 is substantially identical to the first embodiment but does not embody a valve for controlling

sand discharge. Here again the ultimate height of the pile/adjuster combination is controlled by gradually raising the adjuster until a desired depth of sand is obtained in chamber 14.

From the foregoing it will be appreciated that the method of the invention for the erection of a temporary structure, such as a bridge, has the following considerable advantages: Since the pile is driven in by rotating it alternately in opposite directions and the spiral blade 7 of pile 9 functions not only to drive the pile into the ground but also to tightly compact the surrounding soil, the pile can be supported by the ground, even soft ground, with an increased horizontal bearing power and an increased vertical bearing power. The pile can be driven into the ground regardless of the nature thereof and is easily driven even into a gravelly soil.

Further, the rotary method of driving the pile having the spiral element, such as blade 7, is much less noisy than the conventional method in which a pile is driven into the ground by impact, and is vibration free.

Another advantage of the pile of the present invention is that, since the pile only comes directly into contact with the ground is occupies, when the present invention is used to erect a temporary road in agricultural land for instance, the land is not damaged by the erection work and restoration is made easy. Further, for example, when the pile is driven into a river bed, or the like, watersealing is not required.

Moreover, since according to the present invention all work necessary for the erection of a temporary

structure, e.g. a bridge, can be carried out using a single mobile crane, the work can be proceeded with by progressively extending the bridge to any length or width, which work can be carried out easily with high efficiency and with the use of a limited quantity of equipment, even on a narrow site.

Although the pile means provided with a spiral propelling element according to the present invention has been described and shown above as being used as a temporary bridge pier, there is, of course, no reason why it should not be used as a permanent bridge, pier, etc., if necessary.

It is to be understood that although certain forms of this invention have been illustrated and described, it is not to be limited thereto.

CLAIMS

1. A method of erecting a structure, for example a temporary bridge, comprising the steps of driving a cylindrical pile into the ground under a self-propelling action caused by rotation of the pile by external force, stopping driving of the pile when it reaches a predetermined depth, introducing into the pile from above a height adjuster which extends partially into the pile, adjusting the extent of projection of the height adjuster into the pile, repeating the above procedure to drive and adjust the height of a number of the piles, and erecting a structure on the driven piles.

2. A method according to claim 1 comprising the further step of reversing rotation whilst preventing extraction displacement of the pile thereby to compact soil around the pile.

3. A method according to claim 2 comprising supplying consolidation material to be compacted with the soil.

4. A method according to claim 2 or claim 3 comprising driving the pile in a number of stages with compacting operations therebetween.

5. A method according to any of claims 1 to 4, wherein adjustment of the extent of projection of the height adjuster into the pile comprises introducing into

an adjuster-receiving space of the pile a selected quantity of sand or the like on which the adjuster rests.

6. A pile arrangement for use in the method of any of claims 1 to 5 comprising a hollow pile which is closed at one end and open at the other, the pile having a spiral propelling element on its exterior and extending along a substantial portion of its length and further having an internal partition spaced from its open end to provide a chamber receiving sand or the like, and a hollow height adjuster which is constructed to project into the chamber and to contain sand or the like to be controllably discharged through its bottom to vary the depth of said within the chamber and thus the extent to which the adjuster projects from the chamber.

7. A pile arrangement according to claim 6, wherein the propelling element is in the form of a spiral blade.

8. A pile arrangement according to claim 6 or claim 7, wherein the pile has on its closed end tip blades adapted on driving-in rotation to displace soil upwards.

9. A pile arrangement according to any of claims 6 to 8, wherein the height adjuster comprises a valve in its bottom to control delivery of sand or the like from the interior of the adjuster into the chamber below the adjuster.

FIG 1

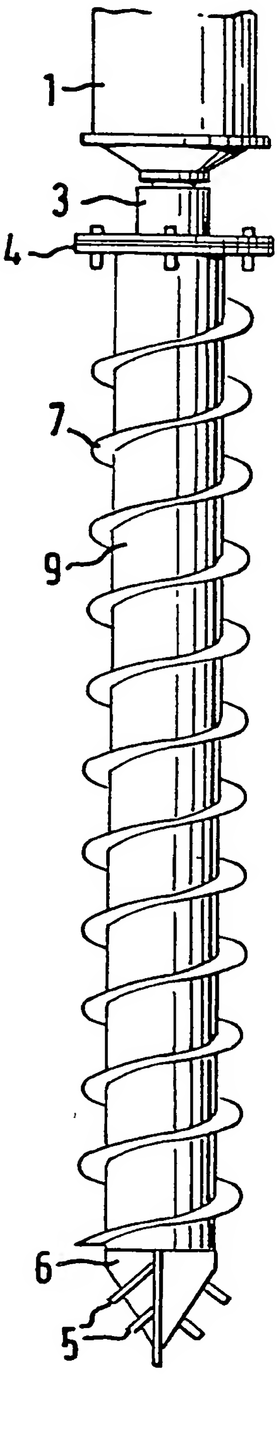
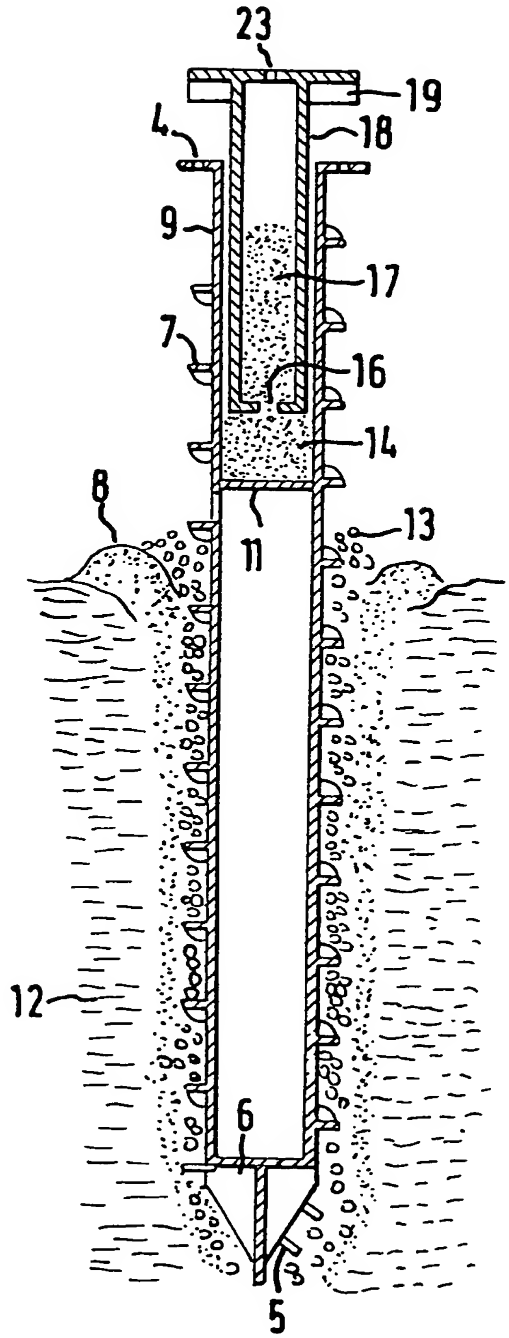


FIG. 2



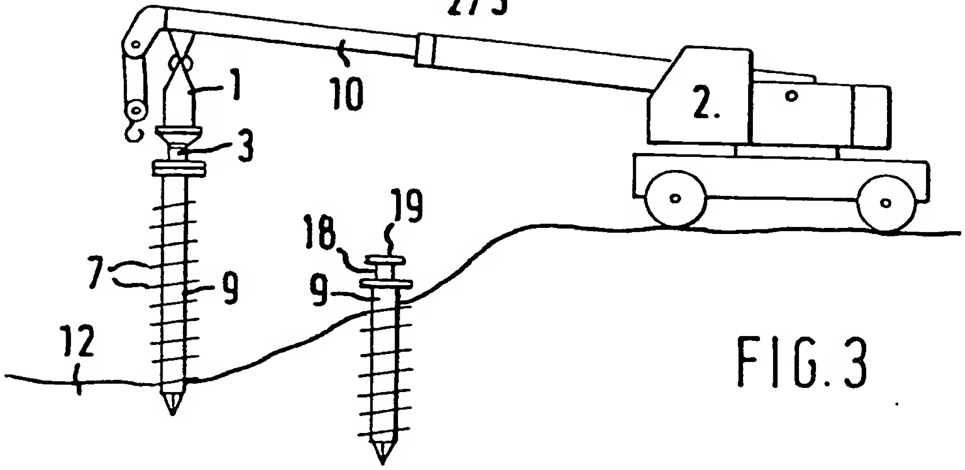


FIG. 3

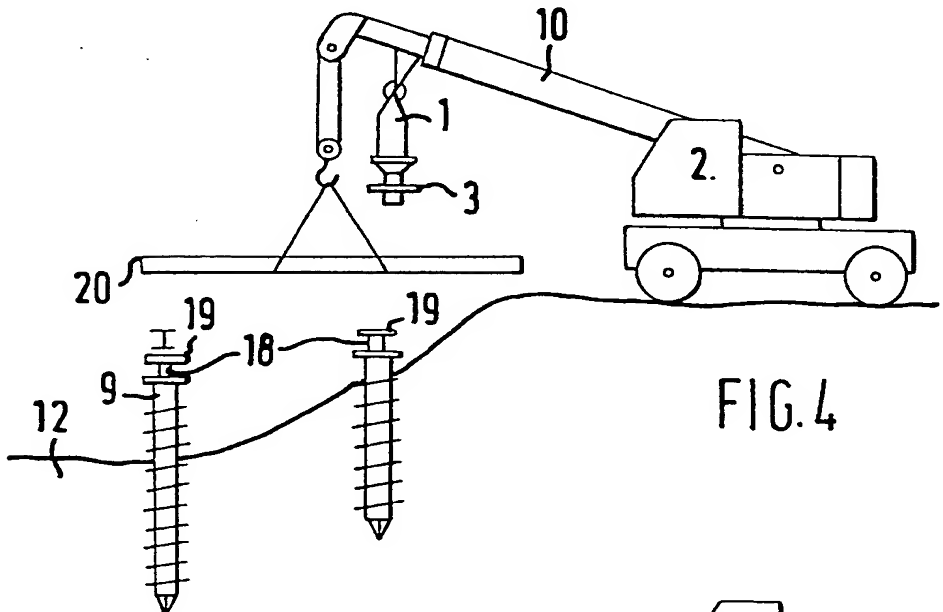


FIG. 4

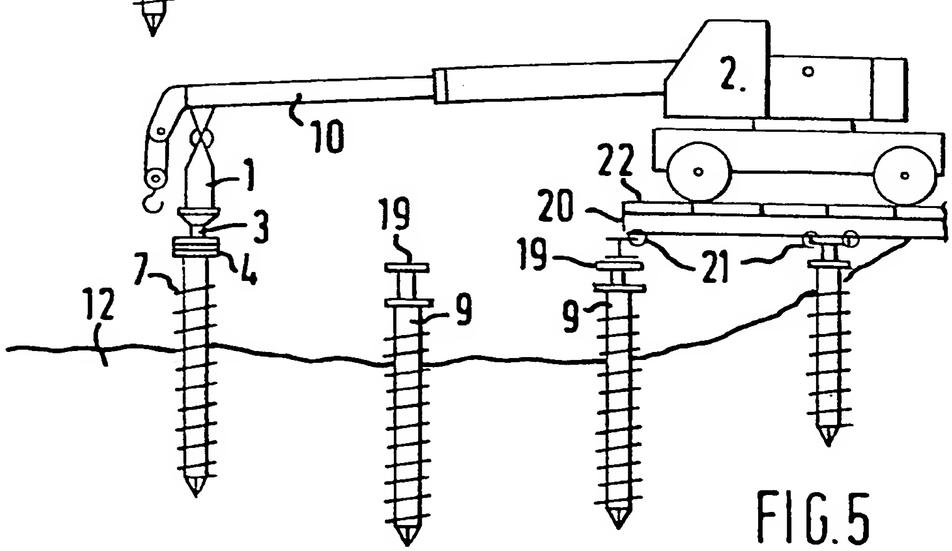


FIG. 5

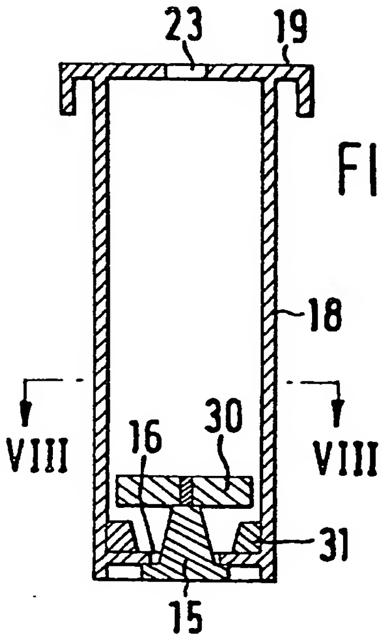


FIG.6

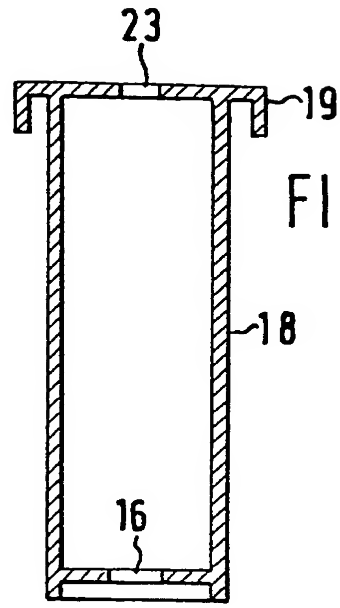


FIG.9

FIG.7

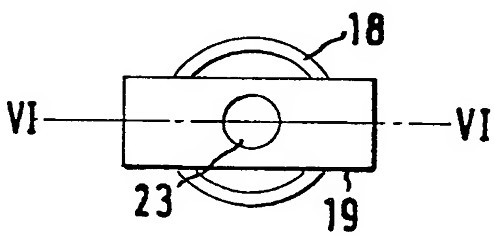


FIG.10

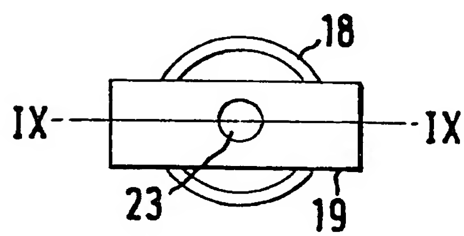


FIG.8